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A SEPTIC TANK FOR FARM HOMES

H. L. BELTON AND J. P. FAIRBANK

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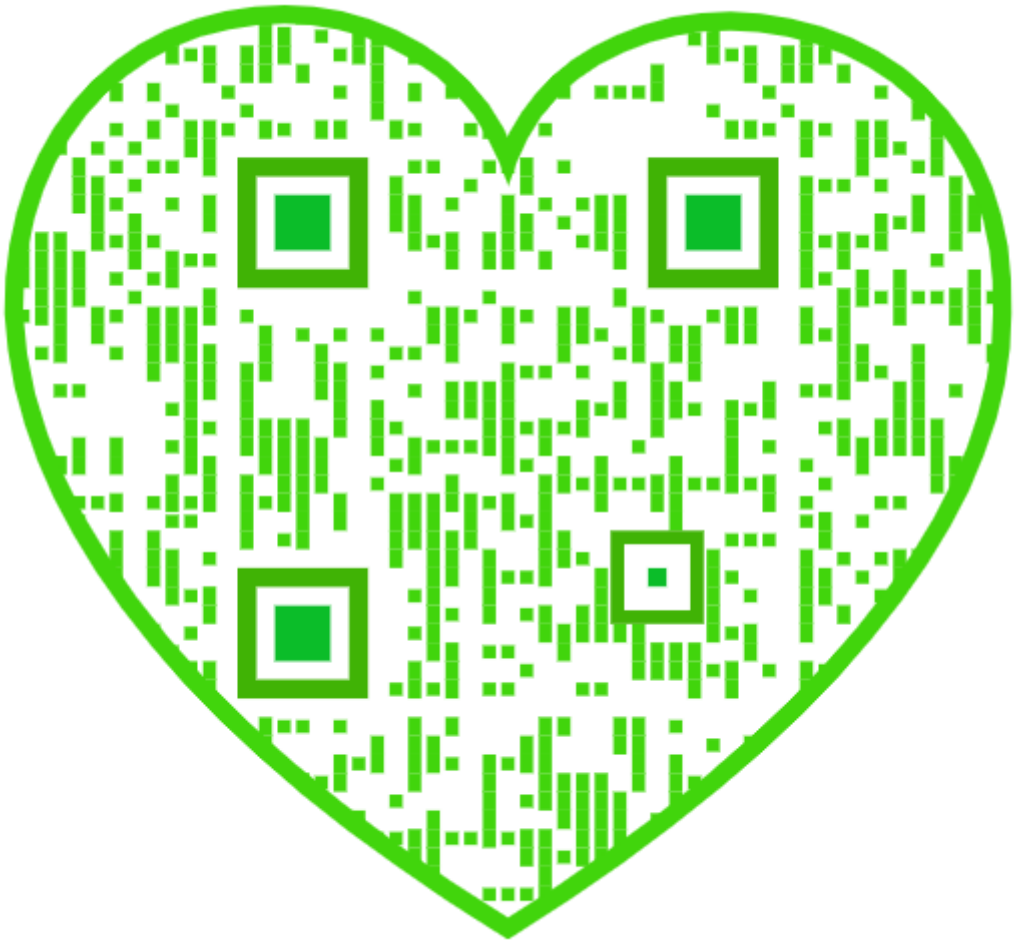

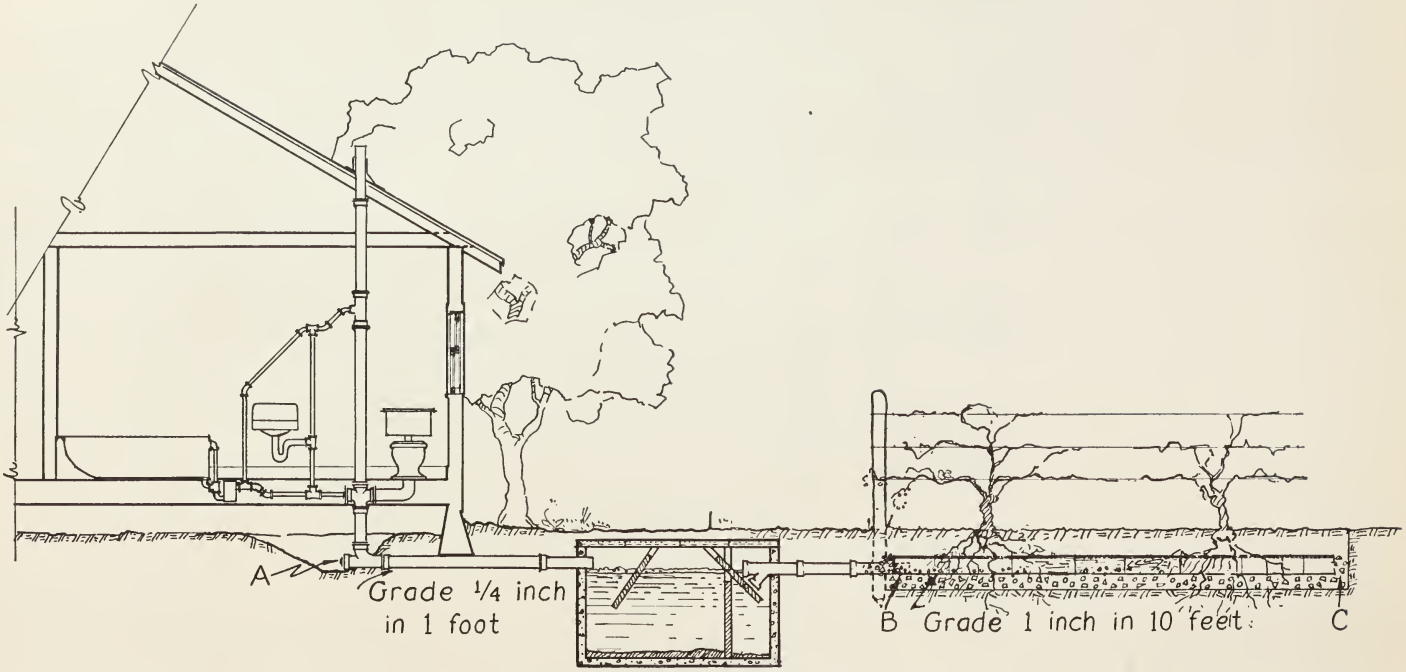

Fig. 1.—Cross section of complete system.

A SEPTIC TANK FOR FARM HOMES[1]

H. L. BELTON[2] AND J. P. FAIRBANK[3]

The convenience of water piped into the house is enjoyed by nearly three-fourths of the farm families in California. The full advantage of having running water in the dwelling, however, can be obtained only if the sewage disposal system is safe and free from annoyances. A satisfactory method of sewage disposal for most rural homes is a septic tank and a subsurface drainage system. Leaching cesspools, although suitable in some instances, are not generally recommended because of the danger of contaminating wells. Under many conditions, furthermore, they fill up in time because the surfaces of the pit become watertight.

The septic tank is but one unit of the complete sewerage disposal system, the other important parts being the sanitary plumbing in the house, the plumbing to the septic tank, and the subsurface drainage system (fig. 1).

All sewage and waste water from the plumbing fixtures flow into the septic tank, where the more solid materials are reduced in volume and are largely changed to liquid by the action of anaerobic bacteria. The liquid effluent flows from an outlet near the top of the tank into a drainage system, where it filters into the soil. Although the liquid entering the disposal line is nearly clear, it is not pure water and should not be allowed to enter wells or other sources of domestic water supply. The final purification takes place in the upper layer of the soil, not only by filtering, but also by the action of bacteria. If exposed to the open air, as in open ditches or pools, the liquid will give off objectionable odors and will be a source of contamination that may be carried by insects or animals.

THE FUNCTION OF THE SEPTIC TANK

The septic tank is merely a water-tight container that provides a proper environment for the bacteria. It should quietly retain the sewage and waste water two to four days. Agitation of the contents is minimized by baffles across the tank that also serve to prevent solids from escaping through the outlet.

[1] This publication supersedes Circular 270, "A Farm Septic Tank," now out of print.

[2] Associate in Agricultural Engineering.

[3] Extension Specialist in Agricultural Engineering.

When additional sewage enters the tank from the house, the liquefied products resulting from the bacterial action flow out into the drain line. A portion of the solids that is never completely liquefied forms a black sludge, which generally settles in the bottom but which is in part carried out in the effluent. Because of the gradual accumulation of this sludge, a septic tank must be thoroughly cleaned at intervals depending upon its size and upon the amount of sewage. The scum or mat that

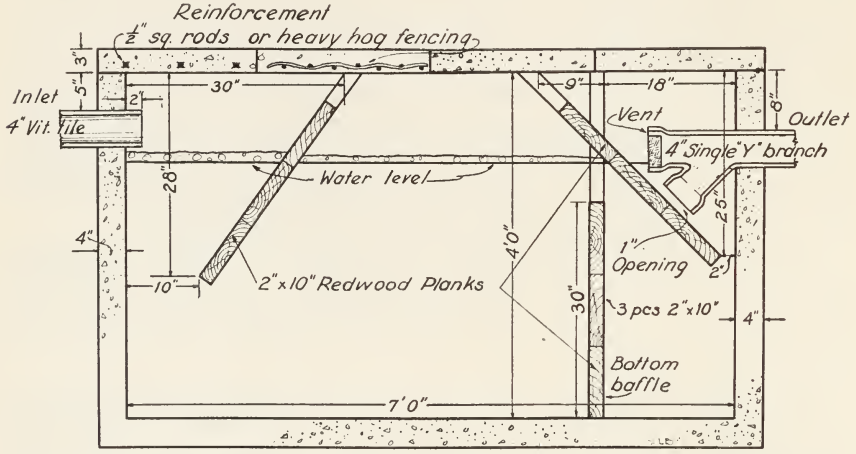

Fig. 2.—Longitudinal view of septic tank. The size shown is recommended for not more than 7 persons.

usually forms on the surface of the liquid does not, however, indicate that the tank needs cleaning.

Typhoid stools and other infectious matter should be disinfected before disposal through the toilets. Excessive amounts of disinfectants should not be added to the sewage, for they may destroy the useful bacteria in the tank.

TYPE OF TANK

The chief requirements are that the tank be large enough, that it be water-tight, adequately baffled, accessible for cleaning, and constructed of materials which do not quickly decay or rust. Simplicity is desirable.

Ready-built septic tanks of different types and sizes are manufactured commercially and are sold ready to install. They are made of steel, of wood, and of large concrete or vitrified clay pipe; and, in general, they have proved satisfactory when correctly installed. As their most common fault is the lack of capacity, the purchaser should select a size suitable for his conditions. The net capacity should equal at least twice

the amount of water used daily in the house. Since this amount averages from 20 to 40 gallons per day per person, for a two-day minimum retention period the septic tank should have a capacity of at least 40 to 80 gallons (5½ to 11 cubic feet) per person.

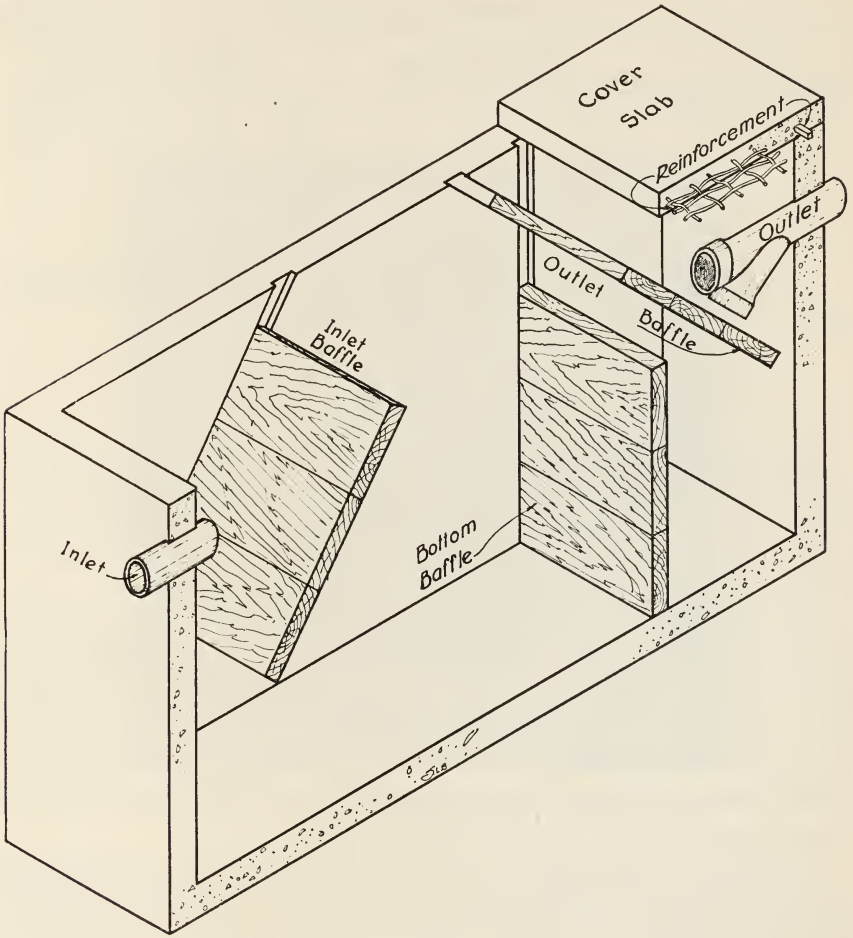

Fig. 3.—Half-section view of septic tank.

A HOMEMADE SEPTIC TANK

This circular describes a simple but satisfactory type of septic tank, widely adopted in California during the past fifteen years. As shown (figs. 2 and 3), it is made of poured concrete; but it may be made of rot-resistant wood.

The following table gives the inside measurements of three different

sizes of tanks. The first is recommended for a family of 4 to 7 persons, the second for 8 to 11, and the third for 12 to 15 persons in the household.

TABLE 1

RECOMMENDED SIZES OF TANKS

No.	Number of persons	Inside measurements			Thickness of concrete			
		Width	Length	Depth	Sides	Ends	Floor	Top
		feet	*feet*	*feet*	*inches*	*inches*	*inches*	*inches*
1	4 to 7	3	7	4	4	4	4	3
2	8 to 11	3½	9	4	5	5	4	3½
3	12 to 15	4	10	4	6	6	4	4

One septic tank may serve two or more dwellings when the total number of persons does not exceed the rated capacity.

TANK LOCATION

The septic tank is normally located not further than 50 feet from the house but may be much closer.[4] It should not be under a foundation, or under permanent walks, or driveways which may interfere with uncovering it for cleaning. A leaky septic tank near a well or spring is, of course, dangerous.

The tank is usually constructed so that the cover is flush with the ground, or slightly lower. The top of the outlet line, accordingly, will be 12 to 16 inches below the ground level, a depth that has proved satisfactory when good soil conditions for drainage exist. A high water table at certain seasons of the year, or heavy clay loam, or hardpan near the surface may make it advisable to keep the top of the tank above ground level, thus obtaining a drainage outlet nearer the surface.

The fall of the sewer pipe from the plumbing fixtures into the septic tank should be not less than ¼ inch to the foot. This standard must be considered in determining the location of the tank and the depth below the ground surface.

If the tank is located a considerable distance from the house and the ground is level, it must be placed deep enough to provide sufficient fall for the sewer line. This arrangement necessitates a deeper drainage system, which in general is undesirable and increases the cost.

The sewer may enter the tank on either side of the center in the end wall if that placing makes for convenience.

[4] One city has an ordinance requiring septic tanks to be at least 10 feet from the foundation. Within city limits the sanitary plumbing code of the municipality should be recognized.

DIRECTIONS FOR BUILDING

The following detailed directions for building apply to the No. 1 tank for the average family up to 7 persons. For the No. 2 and No. 3 tanks the dimensions should be increased in accordance with those shown in table 1.

Preparing for Excavation.—Select the tank location. Lay two planks 3 feet 8 inches apart (fig. 4). Level and hold them in a flat position

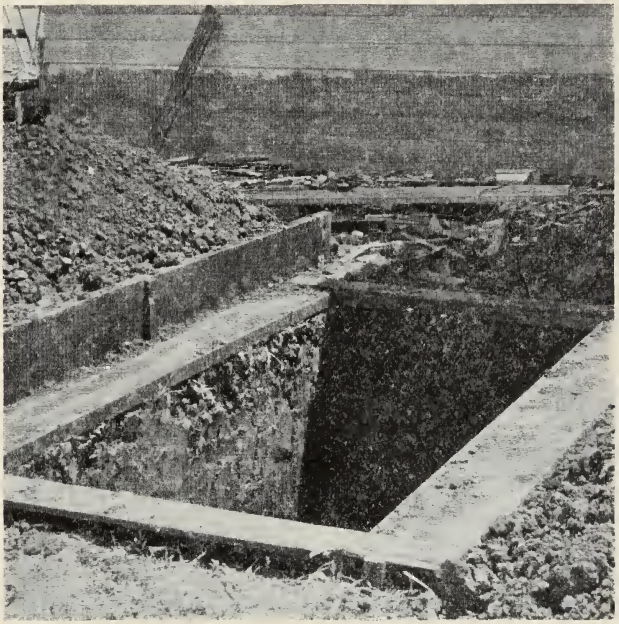

Fig. 4.—The 2 × 10 inch planks laid about the hole are later used as baffle boards.

against stakes driven into the ground. Across the planks nail two 1 × 6 inch boards to form a rectangular frame with inside dimensions 7 feet 8 inches by 3 feet 8 inches (fig. 4). This frame about the top of the hole prevents the crumbling of the earth on the freshly poured concrete during construction, and provides a working edge from which a plumb bob may be suspended to aid in digging perpendicular walls. If the earth is such that it might cave in, the hole must be made larger to accomodate an outside form. Under ordinary conditions the hole is excavated to a depth of from 4 feet 7 inches to 5 feet below the bottom of the frame. This places the tank 0 to 5 inches, and the top of the outlet pipe 12 to 16 inches, below the surface. Local conditions, however, determine the depth of the tank.

The Forms.—The forms are so designed that they can be readily removed in sections without damage and used repeatedly. This feature makes them more valuable to a community. Many farm centers own sets of forms, which they rent at a nominal charge to pay for the lumber

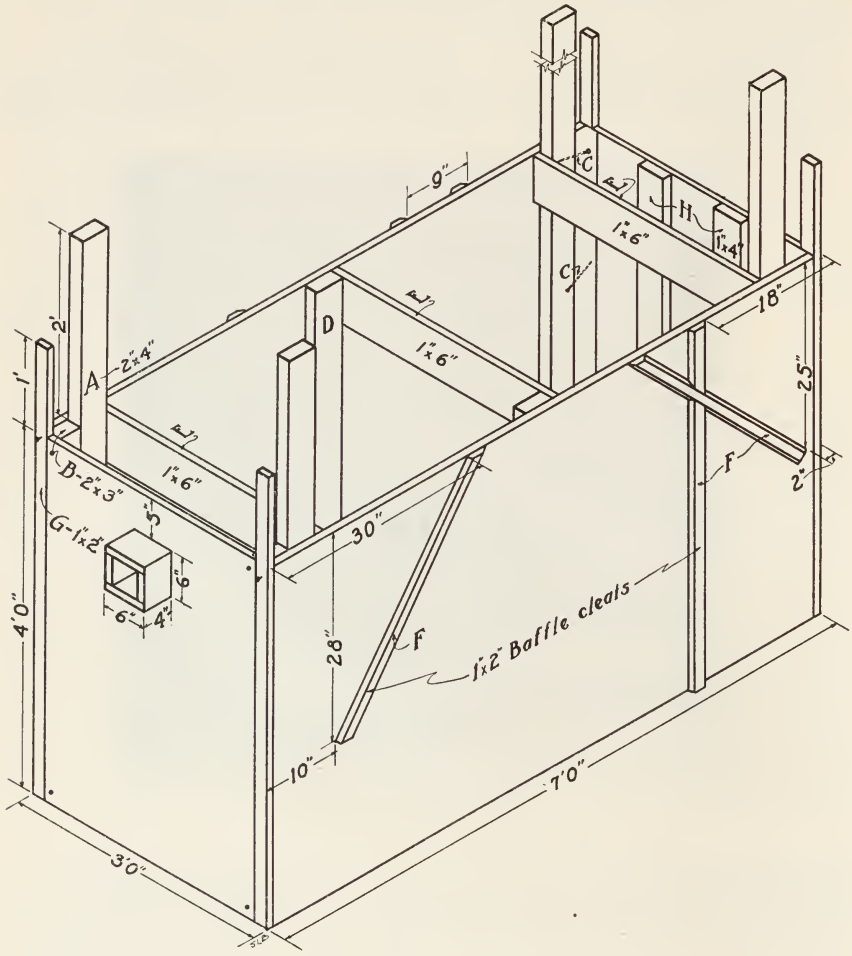

Fig. 5.—View of form for septic tank.

and minor repairs. Sets have been used twenty to thirty times. Oiling the forms before use adds to their life and prevents concrete from sticking to the wood.

The forms should be made of common lumber surfaced on one side, the outside measurements to correspond to the inside measurements of the tank. Figure 5 gives the necessary dimensions for constructing the inside form.

Side Panels.—The sheathing, which may be 1×6 inches, is nailed firmly to the 2×4 inch studding (*A* and *D*, fig. 5). The 1×2 inch baffle cleats (*F*, fig. 5) are now nailed on the side panels to form grooves for

Fig. 6.—Squaring up and starting the side-wall form.

Fig. 7.—The side-wall sheathing should be well nailed, and the boards drawn close together.

the baffle boards. They should be slightly beveled on the edges to insure easy removal of the side panels. Other views of the construction are shown in figures 6, 7, 8, and 9.

Cross Braces.—Six 1×6 inch cross braces (*E*, fig. 5) hold the side panels to the proper width. The three lower braces should be 6 inches above the bottom of the form.

End Panels.—The end panels, which are constructed as shown in figure 10, are held to the 2×3 inch studding (*B*, fig. 5) which fits against the studding *A* and the end of the side-wall sheathing. Two 8d common nails (*C*, fig. 5) at each corner hold the studding *B* in proper position. Four 6d nails are sufficient to hold the end panel to the studding *B*.

Fig. 8.—Nail the 1×2 inch baffle cleats firmly in position after trimming the side-wall sheathing.

Corner Strips.—The corner strips (*G*, fig. 5) are held to the studding *B* by one small nail each, tacked near the top. These nails should be withdrawn before they are covered with concrete.

Hanging the Form.—For convenience in setting the form in position, the studding *A* (figs. 5 and 11) should project 2 feet above the top edge of the wall sheathing. After being lowered into the hole, the form should be blocked up level to allow for a 4-inch bottom of concrete, and squared up in the hole so that all walls will be of the same thickness. Next, 1×6 inch hanging boards (fig. 12) are nailed firmly to the 2×4 studding *A* and to the 2×10 inch plank frame that was placed about the top edge of the hole. The blocking is then removed, and the form is ready for the concerete.

Construction of Tank.—The tank should be constructed with 4-inch sides and 4-inch bottom. The top must be 3 inches thick and reinforced. A 1 :2½ :4 mixture of concrete material is recommended; that is, 1 sack

or 1 cubic foot of cement, 2½ cubic feet of sand, and 4 cubic feet of crushed rock. Both the sand and the rock should be clean and free from organic matter. The sand should vary from fine to ¼ inch in size; the

Fig. 9.—Assembling side-wall forms and placing the 1 × 6 inch cross ties in the proper position.

rock, from ¾ to 1 inch. Clean, well-graded gravel may be substituted for the rock and sand. This should be mixed in a proportion of 1 sack of cement to 4½ cubic feet of gravel. Enough water should be added to give the entire mixture a jelly-like consistency. Too much water is harmful, for the strength of the concrete is reduced by adding more water than is necessary for a workable mixture. The concrete should be thor-

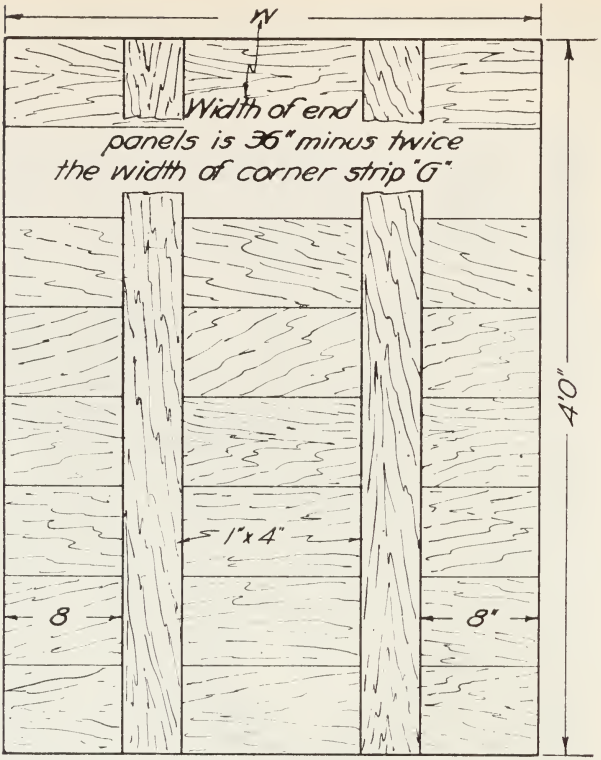

Fig. 10.—End panel. Four 6d nails, one at each corner, hold the end panels to the 2×3 inch studding *B*, figure 5.

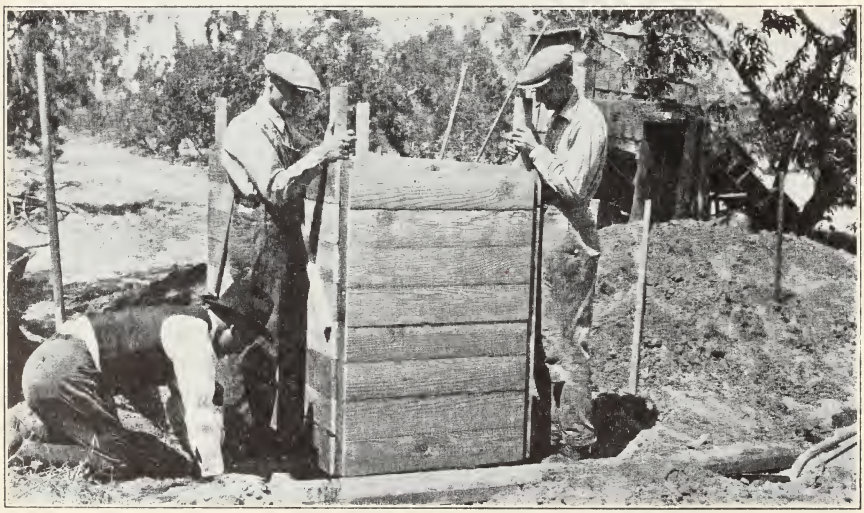

Fig. 11.—The completed form ready to be lowered into the hole.

oughly tamped as it is poured, thus insuring smooth, water-tight walls; a 1×2 inch V-shaped strip will be found convenient for tamping and working it into place. The concrete should be poured evenly about the walls. (Do not crowd the forms out of alignment by pouring too much concrete in one place.) When the concrete is within 11 inches of the top at the inlet end and 14 inches at the outlet end, the $6 \times 6 \times 4$ inch boxes

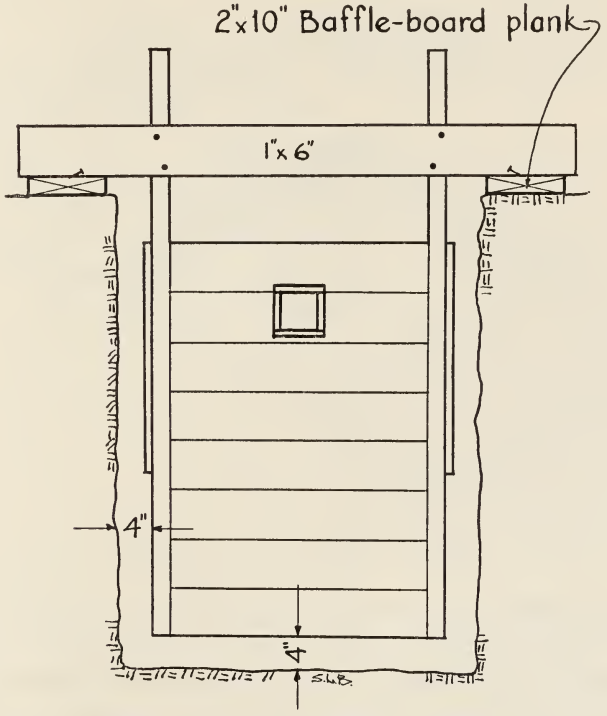

Fig. 12.—End view of completed form suspended in the hole.

(fig. 5) should be placed. Small nails driven into the form before it is lowered into the hole will show the exact position of these boxes. Continue pouring the walls, truing the top edge with a trowel or block. Since the walls are poured first, some concrete will work out from under them and will spread over the bottom of the hole. It should be tamped and smoothed into place along with the tank floor, which is poured immediately after the walls. Do not allow the concrete floor to extend any higher than the bottom of the forms, or the latter cannot be removed readily.

Construction of Cover.—Level off the ground nearby and stake on edge, in parallel lines 3 feet 8 inches apart, two 1×4 inch boards 8 feet 5 inches long. Cut and nail in position 1×4 inch cross pieces forming four rectangular compartments with inside dimensions 23 inches by 3

feet 8 inches (fig. 13). Fill the bottom of these spaces with fine damp earth or with sand to a smooth level surface, leaving 3 inches for concrete. Pour about ¾ inch of concrete and immediately place the reinforcing, which may be heavy hog fencing or three ½-inch steel rods in each slab. Continue pouring the concrete, leaving the slab smooth and level with the top edge of the form.

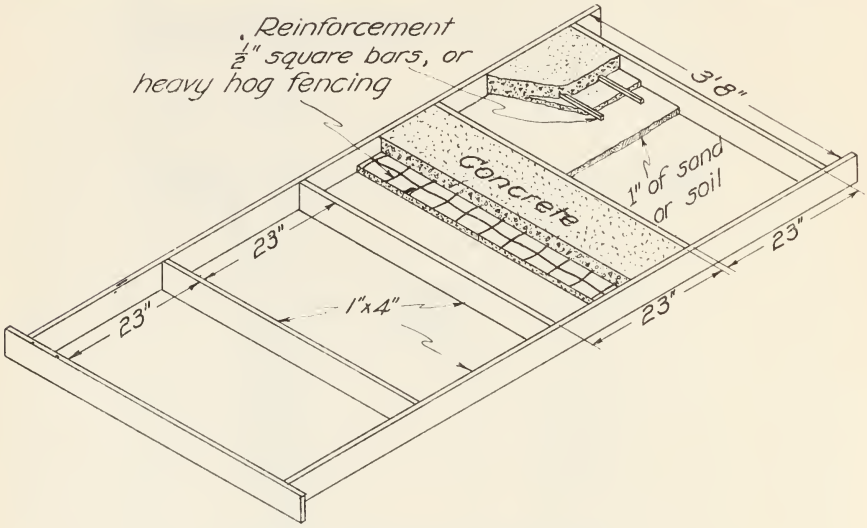

Fig. 13.—The form for cover slabs.

Removing Tank Forms.—After the concrete has taken its initial set (usually within one hour), the 1 × 2 inch strips (*G*, fig. 5) at the four corners may be tapped lightly with a hammer and drawn out. Their removal tends to prevent the cracking of the concrete at the corners. When the concrete has set 16 to 24 hours, the forms may be taken out. First remove the 1 × 6 inch hanging boards and the cross braces *E*, then the 2 × 3 inch corner studding *B* by prying them inward and drawing nails *C*. Next, remove the end panels. The side panels may be lifted out intact, care being taken not to break the concrete around the edges of the grooves into which the ends of the baffle boards are to be inserted. Remove the 6 × 6 inch boxes from the wall.

Curing the Concrete.—The concrete should not be permitted to dry rapidly. After it has taken its initial set (usually within one hour) the exposed surfaces may be covered with wet sacks until the forms are removed (usually 16 to 24 hours for the tank). After removing the forms, cover the tank and keep it wetted for several days. The cover slabs may be protected with wet sacks for a few hours and then kept wet for one week by means of wet earth or by flooding.

Completing the Tank.—Point up any porous areas with a mortar made of equal parts of fine sand and cement. Insert the outlet Y branch in position as shown in figure 2, using sand-cement mortar to secure a water-tight joint in the wall. The upper branch of the Y should be plugged with mortar, except for a small vent at the top.

The 2 × 10 inch baffle boards should be fitted loosely in the grooves. A small amount of mortar in the grooves at the ends of the top boards will prevent them from floating when the tank is filled with sewage.

The sewer pipe from the house projects 2 inches into the tank; it should be mortared in place.

The cover slabs may be placed in position after being cured for at least one week and should be installed right side up—that is, with the reinforcing steel near the bottom. Unless the tank is covered with several inches of dirt, the cover slabs should be sealed with a lean mortar so that the slabs may be more readily removed. A proportion of 1 part cement to 6 parts of sand is recommended.

Connecting the Tank.—The sewer pipe leading from the house to the septic tank should be laid to a grade of not less than ¼ inch to the foot and embedded firmly in the ground. Although cast-iron pipe with tightly leaded joints is recommended, vitrified clay sewer pipe with cemented joints may be used between the house foundation and the tank. To clean out any mortar that might obstruct the inflowing sewage, a swab made from a piece of burlap on a stick should be run through each length of pipe after the joint is cemented.

The plumbing fixtures and the sewer line should be installed and vented in accordance with standard sanitary plumbing practice. Neither a trap in the sewer line between the house and the septic tank nor a vent in the septic tank is required. A clean-out plug, as shown at *A*, figure 1, is recommended.

FINAL DISTRIBUTION OF EFFLUENT

The effluent from the tank may be utilized for the subirrigation of alfalfa, berries, or trees, and for vegetables which are cooked before eating or which, if eaten raw, do not come into contact with the ground. The location of the disposal area depends upon local conditions. The tank should not be near a well or spring nor in the ground where water may stand at or near the surface; nor should it be emptied into a stream or open ditch. Trees, vines, or shrubs may usually be grown to advantage in the disposal area, for the effluent serves the plants through subirrigation. In general, under California conditions, the roots aid in the operation of the disposal system and rarely plug the drainage line.

A vitrified sewer pipe, at least 6 feet long, with cemented joints is used to carry the effluent from the tank into the subsurface drain line. A satisfactory type of drain line is an inverted V-trough, laid at a grade of 1 inch in 10 feet, on 6 inches of rock or gravel ¾ to 1½ inches

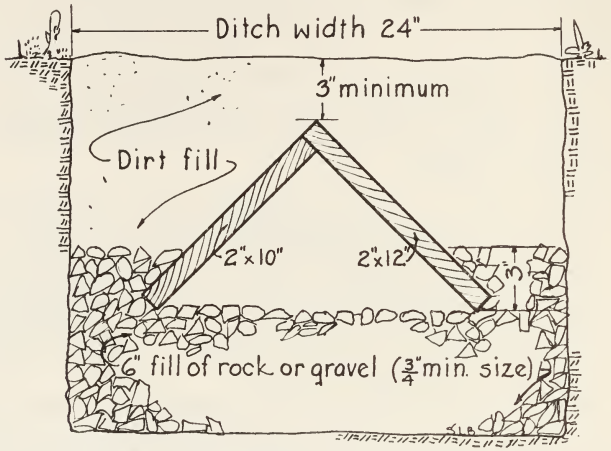

Fig. 14.—Cross section of V-trough drain line

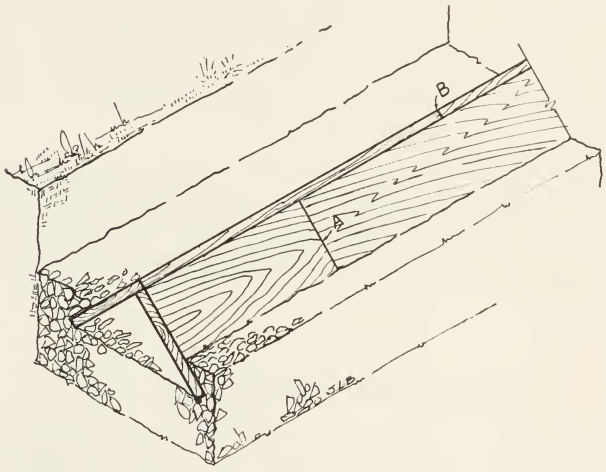

Fig. 15.—View of V-trough in trench. Joints should be staggered as at *A* and *B*.

in size, back-filled with similar material and covered with earth (figs. 14 and 15). Use at least 10 feet of trough per person up to 100 feet. If additional length is required, branch lines are recommended.

The trough may be made of a 2×10 inch and a 2×12 inch heart common grade redwood or preservative-treated lumber, or of half sections of 12-inch concrete pipe (figs. 16 and 17).

The vitrified sewer line from the tank should extend at least 6 inches into the trough (*B*, fig. 1). The opening between the sides of the trough and the pipe should be filled with gravel and mortar to prevent the

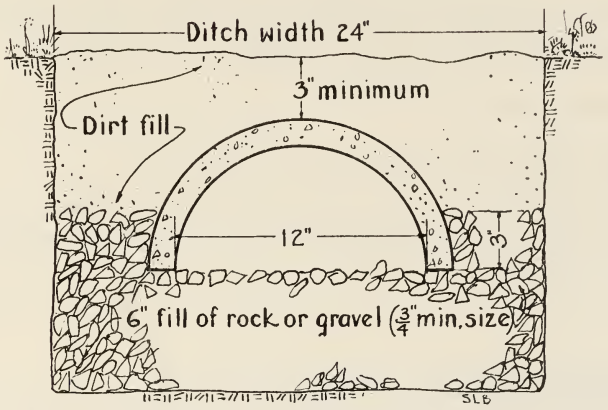

Fig. 16.—Cross section of half-section pipe drain line.

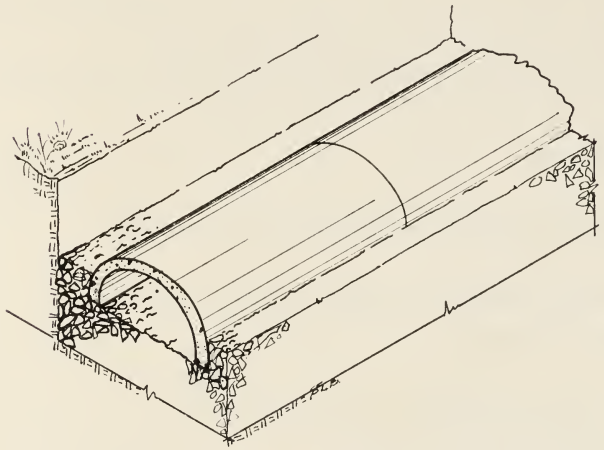

Fig. 17.—View of half-section concrete pipe in trench.

entrance of dirt or gophers, and the extreme end of the trough should be closed with a sufficient amount of gravel to prevent gophers from entering (*C*, fig. 1).

Placing the Tank in Operation.—After all cemented joints have set firmly, run 150 to 200 gallons of water into the tank; it is then ready for use. The addition of a "starter" or of bacteria is not necessary.

MATERIALS REQUIRED

The materials necessary for a septic tank 3 feet wide, 4 feet deep, and 7 feet long, recommended for 4 to 7 persons, are as follows:

Concrete Materials:

2 cubic yards crushed rock ¾ inch to 1 inch in size.
1 cubic yard sand.
12 sacks cement. (If crushed rock is not available, 2 cubic yards of clean, well-graded gravel, suitable for good concrete, may be substituted for the rock and sand.)

Tile:

1 vitrified single-branch Y sewer tile, size 4-inch.
Vitrified bell-neck sewer tile,[5] size 4-inch.

Drainage Line:[5]

2″ × 10″ and 2″ × 12″ heart common grade redwood or preservative-treated lumber, or half section of 12-inch concrete pipe.
1½ cu. ft. of ¾-inch to 1½-inch rock for each foot of drainage line.
1 pound 20d nails for each 25 feet of trough.

Baffle Boards:

3 pcs. 2″ × 10″ × 10′ rough common redwood or cedar; 6-inch and 12-inch widths may be substituted if 10-inch is not available.

Cover Forms (common lumber surfaced one side):

3 pcs. 1″ × 4″ × 12′.

Forms (common lumber surfaced one side):

Side walls, 9 pcs. 1″ × 6″ × 14′.
End walls and braces, 6 pcs. 1″ × 6″ × 12′; 2 pcs. 1″ × 6″ × 8′.
Hanging boards and boxes, 1 pc. 1″ × 6″ × 12′.
Baffle cleats and corner strips, 3 pcs. 1″ × 2″ × 12′.
Long and center studding, 2 pcs. 2″ × 4″ × 16′.
Corner studding, 1 pc. 2″ × 3″ × 16′.

Nails:

2 pounds 8d common wire nails.
2 pounds 6d box nails.

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[5] Amounts of sewer tile and drainage line not given, as local conditions govern quantity required.

MAINTENANCE OF THE SEWERAGE SYSTEM

Close attention to details of construction reduces the possibility of future annoyance with the septic tank sewerage system.

Use of Disinfectants.—Although large amounts of disinfectants or cleaning agents are detrimental to the bacterial activities in the tank, moderate amounts may be used.

Grease Traps.—A grease trap need not be installed, provided waste fats and grease from the kitchen sink are deposited with the garbage. It may, however, be desirable if an excessive amount of greasy water is discharged into the tank. It must be frequently cleaned to prevent its becoming a nuisance. For design of such traps see Farmers' Bulletin 1227.[6]

Stoppage of Sewage in the System.—The most common complaint concerning sewage disposal systems is that waste water leaves the plumbing fixtures slowly, or that toilets overflow. This trouble is caused by stoppage in the pipe, tank, or drain line. To locate and remedy it, try the following procedure:

Open drain line near tank. If, when the line is opened, water rushes from the drain line, the trouble is in the drainage system. If the soil around the line is saturated along the length of line (not because of natural high water table), the drain is plugged, or more drain line is needed.

If there is no rush of water when the line is opened, the stoppage is at the inlet of the tank or in the sewer line between the house and the tank. Remove the second cover slab from the inlet end of the tank. Remove the scum from in front of the inlet baffle. Probe around the inlet. If the stoppage is not thus removed, it is in the sewer line. To correct this, run heavy wire, a rod, or a hose with nozzle jetting water, through the sewer line. If there are no clean-out plugs in the sewer line, break a joint to gain entrance. After the line is cleaned, repair the broken joint with mortar.

Four-inch drain tile has been used for the drainage line in many disposal systems. In time the soil about the joints of the tile becomes impervious. In case this difficulty occurs frequently, the drain pipe should be relaid in a bed of coarse gravel; or the open-bottom drain line described in this circular should be substituted for the 4-inch tile line.

Cleaning the Tank.—An investigation of the performance of septic

[6] Warren, George M. Sewage and sewerage of farm homes. U. S. Dept. Agr. Farmers' Bul. 1227:54. 1922.

tanks that had been in use for three to ten years was made by the authors in 1929 and 1930. The results of this study, which covered the major portion of California, indicated that sludge accumulated in the bottom of the No. 1 tank at the rate of about 1 inch per person per year. Because of this accumulation of sludge the capacity of the tank is gradually diminished and increasing quantities of sludge are discharged into the drain line. This, in time, will cause stoppage of the drainage system.

On the basis of this investigation it is recommended that the No. 1 tank described in this circular be cleaned at about 18 person-years' use —that is, in three years if 6 persons are in the household, or six years if but an average of 3 persons. For the No. 2 tank, 27 person-years' use is recommended prior to cleaning; for the No. 3 tank, 36 person-years' use.

To clean the tank, take off the two center cover slabs. Remove the scum or mat with a shovel. The liquid and a portion of the sludge may be removed by a pump if the contents are agitated during pumping. Allowing water to flow into the tank aids in pumping. Bailing the liquid is often the practical method; remove about 200 pailfuls or 470 gallons. Disposal of the contents to prevent nuisance is simple. Bury the scum and run the liquid into a trench that can be filled in after a few hours.

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REGULATIONS OF THE STATE BOARD OF HEALTH GOVERNING USE OF SEWAGE FOR CROP IRRIGATION PURPOSES

RULE 3. *Settled or Undisinfected Sewage Effluents.* Effluents of septic tanks, Imhoff tanks or of other settling tanks, or partially disinfected effluents of sprinkling filters or activated sludge plants or similar sewages, shall not be used to water any growing vegetables, garden truck, berries, or low-growing fruits such that the fruit is in contact with the ground, or to water vineyards or orchard crops during seasons in which the windfalls or fruit lie on the ground. Such sewage, effluents or any sludge or screenings shall not be permitted in ditches or pipes which may be used to irrigate vegetables, garden truck, berries, or low-growing fruit.

Nursery stock, cotton, and such field crops as hay, grain, rice, alfalfa, sugar beets, fodder corn, cowbeets, and fodder carrots may be watered with such settled or undisinfected or partially disinfected sewage effluents provided that no milch cows are pastured on the land while it is moist with sewage, or have access to ditches carrying such sewage.

AMENDMENT JANUARY 2, 1934:

However, such sewage may be used for irrigating growing vegetables grown exclusively for seed purposes in fields where crops are raised and watered not in conflict with this rule.